

FINAL
HAZARD RANKING SYSTEM PACKAGE
FOR
PIKE HILL COPPER MINE
CORINTH, VERMONT

CERCLIS NO. VTD988366720

HAZARD RANKING SYSTEM (HRS) PACKAGE
RESPONSE ACTION CONTRACT (RAC), REGION I

Prepared for:

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Region I
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CORINTH, VERMONT

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SITE DESCRIPTION

The Pike Hill Copper Mine (PHCM) is an abandoned copper mine located off of Pike Hill Road in the Town of Corinth, Orange County, Vermont (Figure 1) [4; 8; 9; 16, p. 8; 43, p. 3]. PHCM is located approximately 1.5 radial miles northeast of the Village of West Corinth, includes a northern and southern mine, and the total mine property encompasses approximately 216 acres (Figure 2) [4; 18, pp. 1, 2]. The geographic coordinates of PHCM, as measured from the equidistant point between the Pike Hill summit and the adit at the Southern Mine, are 44° 03' 26.4" north latitude and 72° 18' 24.9" west longitude [4; 43, p. 1]. There are no tax assessor's maps for the property [20].

PHCM is located on Pike Hill, a large hill in a rural and forested area along the eastern flank of the Green Mountains [4; 8; 18, p. 2; 43, p. 3]. Mine elevations range from approximately 1,640 feet above mean sea level (MSL), at the southern mine, to approximately 1,965 feet above MSL, at the summit of Pike Hill (near the northern mine) [4; 43, p. 3].

Copper was discovered on Pike Hill sometime prior to 1847. Initial attempts to mine the ore at Pike Hill occurred in 1847 [14, p. 70]. The northern and southern mines have historically been referred to as the Union Copper Mine, and the Corinth (and later the Eureka) Copper Mine, respectively [14, p. 70; 18, p. 1,2]. The two mines, eventually designated as the Pike Hill Mines, operated on an intermittent basis from 1847 until 1919 when mining operations at the PHCM property ceased [13, pp. 168-172; 14, pp. 70-76; 17, p. 68; 18, pp. 1-2].

The southern mine is approximately 2,000 feet southeast of the northern mine [4; 43, Fig. 1]. The ore bodies of the northern and southern mines are approximately 350 feet apart [18, p. 2]. There are approximately 20,000 tons of mill and mine dumps (tailings), averaging 1.6 percent copper, scattered over the surface of the two mines [11, p. 9; 18, p. 1]. At the northern mine, there are two tailings piles and at the southern mine, there are three tailings piles and two mine shafts; several adits are located around the Pike Hill hillside [18, p. 2; 25, pp. 2-4; 26, pp. 6, 7, 9-10]. Each tailings pile consists of brownish-orange colored fine-grained material with rock fragments. There is little vegetative growth on the surface of the piles [25, p. 4; 26, pp. 8, 10].

According to the U.S. Bureau of Mines, the ore is a replacement deposit in schist and is composed primarily of sulfide minerals, including pyrrhotite, with pyrite, chalcopyrite, sphalerite, and minor accessory minerals [18, p. 2]. The copper content of the ore ranges from 0.3 percent to 20 percent; the average grade mined during the early operations was probably 3 percent [62, p. 436]. Between 1863 and 1918, approximately 9,085,298 pounds of copper were mined at PHCM [17, p. 68].

The mine tailings are rich in metals and sulfides [54, p. 8]. As water passes over and through the tailings, sulfuric acid is produced and the metals within the tailings are dissolved and mobilized. This results in acid mine drainage [54, p. 8]. Acid mine drainage contributes to an elevated load of metals to Pike Hill Brook and the Waits River [78, pp. 11-12; 79, pp. 5-6].

In October 1993, the Corinth Fire Department was informed that smoke was emanating from the mine fill at the PHCM site [11, p. 1]. According to the U.S. Bureau of Mines, the smoldering was due to spontaneous oxidation and combustion of reactive sulfides present in the mine fill [11, p. 10].

PHCM has been previously investigated by State and Federal agencies, and private companies. As part of the various studies, one or more samples of mine tailings, soil, surface water, and sediment have been collected and analyzed for metals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and cyanide. The results indicate metal concentrations that exceed background levels [45, pp. 17-18, 20-23; 46, pp. 16, 18, 20; 47, p. 17; 48, pp. 19-21; 78, pp. 11-12; 79, pp. 5-6].

HRS DOCUMENTATION RECORD--REVIEW COVER SHEET

Name of Site: Pike Hill Copper Mine

CERCLIS ID: VTD988366720

Contact Persons

Site Investigation: Lisa LaForge, Tetra Tech NUS (978) 658-7899

Documentation Record: Nancy Smith, EPA Region I (617) 918-1436

Pathways, Components, or Threats Not Scored

The HRS site score for PHCM is based on the threat posed by the site to the surface water migration pathway. After a review of the four pathways, it was determined that the ground water, soil exposure, and air migration pathways do not contribute significantly to the overall site score. Therefore, these pathways have not been included in this HRS package.

In addition to metal analyses, source and sediment samples collected during a previous investigation were also analyzed for VOCs, SVOCs, pesticides, and PCBs [53, p. 10]. Acetone detected in a source sample was the only chemical that exceeded the reference criteria [43, pp. 13, 17; 45, p.18]. There were no VOCs, SVOCs, pesticides, and PCBs detected above reference criteria in the sediment samples [43, p. 30; 45, pp. 16-24]. Therefore, only analytical results for metal concentrations were used for scoring purposes in this HRS package.

HRS DOCUMENTATION RECORD

Name of Site: Pike Hill Copper Mine

EPA Region: I

Date Prepared: October 2001

Street Address of Site: Pike Hill Road

County and State: Orange County, Vermont

General Location in the State: East Central

Topographic Map: United States Geological Survey. 1981. West Topsham Quadrangle, Vermont,
7.5-Minute Series (Topographic) [4]

Latitude: 44° 03' 26.4" N

Longitude: 72° 18' 24.9" W [4; 43, p. 1]

Reference Point: The geographic coordinates were measured from the equidistant point
between the Pike Hill summit and the adit at the Southern Mine.

Scores

Air Pathway:	Not Scored
Ground Water Pathway:	Not Scored
Soil Exposure Pathway:	Not Scored
Surface Water Pathway:	100

HRS SITE SCORE

50

WORKSHEET FOR COMPUTING HRS SITE SCORE

	<u>S</u>	<u>S²</u>
1. Ground Water Migration Pathway Score (S_{gw}) (from Table 3-1, line 13)	<u>NS</u>	<u>NS</u>
2a. Surface Water Overland/Flood Migration Component (from Table 4-1, line 30)	<u>100</u>	
2b. Ground Water to Surface Water Migration Component (from Table 4-25, line 28)	<u>NS</u>	
2c. Surface Water Migration Pathway Score (S_{sw}) Enter the larger of lines 2a and 2b as the pathway score.	<u>100</u>	<u>10,000</u>
3. Soil Exposure Pathway Score (S_s) (from Table 5-1, line 22)	<u>NS</u>	<u>NS</u>
4. Air Migration Pathway Score (S_a) (from Table 6-1, line 12)	<u>NS</u>	<u>NS</u>
5. Total of $S_{gw}^2 + S_{sw}^2 + S_s^2 + S_a^2$	<u>10,000</u>	
6. HRS Site Score Divide the value on line 5 by 4 and take the square root	<u>50</u>	

NS = Not Scored

TABLE 4-1
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET

<u>Factor Categories and Factors</u>		<u>Maximum Value</u>	<u>Value Assigned</u>	
DRINKING WATER THREAT				
<u>Likelihood of Release</u>				
1.	Observed Release	550	550	
2.	Potential to Release by Overland Flow			
2a.	Containment	10	NS	
2b.	Runoff	25	NS	
2c.	Distance to Surface Water	25	NS	
2d.	Potential to Release by Overland Flow (Lines 2a x [2b+2c])	500	NS	
3.	Potential to Release by Flood			
3a.	Containment (Flood)	10	NS	
3b.	Flood Frequency	50	NS	
3c.	Potential to Release by Flood (lines 3a x 3b)	500	NS	
4.	Potential to Release (lines 2d+3c) subject to a maximum of 500	500	NS	
5.	Likelihood of Release (higher of lines 1 and 4)	550	550	550
<u>Waste Characteristics</u>				
6.	Toxicity x Persistence	a	10,000	
7.	Hazardous Waste Quantity	a	10,000	
8.	Waste Characteristics	100	100	100

TABLE 4-1
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET
Drinking Water Threat Score (continued)

<u>Factor Categories and Factors</u>		<u>Maximum Value</u>	<u>Value Assigned</u>	
<u>Targets</u>				
9.	Nearest Intake	50	0	
10.	Population			
10a.	Level I Concentrations	b	0	
10b.	Level II Concentrations	b	0	
10c.	Potential Contamination	b	0	
10d.	Population (lines 10a+10b+10c)	b	0	
11.	Resources	5	5	
12.	Targets (lines 9+10d+11)	b	5	5
13.	Drinking Water Threat Score ([lines 5 x 8 x 12]/82,500) subject to a maximum of 100	100	3.33	3.33

HUMAN FOOD CHAIN THREAT

Likelihood of Release

14.	Likelihood of Release (same value as line 5)	550	550	550
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Waste Characteristics

15.	Toxicity x Persistence x Bioaccumulation	a	5E+08	
16.	Hazardous Waste Quantity	a	10,000	
17.	Waste Characteristics	1,000	1,000	1,000

TABLE 4-1
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET
Human Food Chain Threat Score (continued)

<u>Factor Categories and Factors</u>		<u>Maximum Value</u>	<u>Value Assigned</u>	
<u>Targets</u>				
18.	Food Chain Individual	50	45	
19.	Population			
19a.	Level I Concentrations	b	0	
19b.	Level II Concentrations	b	0.03	
19c.	Potential Contamination	b	0.000033	
19d.	Population (lines 19a+19b+19c)	b	0.030033	
20.	Targets (lines 18+19d)	b	45.030033	
21.	Human Food Chain Threat Score ([lines 14 x 17 x 20]/82,500) subject to a maximum of 100	b	100	100
ENVIRONMENTAL THREAT				
<u>Likelihood of Release</u>				
22.	Likelihood of Release (same value as line 5)	550	550	550
<u>Waste Characteristics</u>				
23.	Ecosystem Toxicity x Persistence x Bioaccumulation	a	5E+08	
24.	Hazardous Waste Quantity	a	10,000	
25.	Waste Characteristics	1,000	1,000	1,000

TABLE 4-1
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET
Environmental Threat Score (continued)

<u>Factor Categories and Factors</u> <u>Targets</u>	<u>Maximum Value</u>	<u>Value Assigned</u>	
26. Sensitive Environments			
26a. Level I Concentrations	b	0	
26b. Level II Concentrations	b	135	
26c. Potential Contamination	b	0.05	
26d. Sensitive Environments (lines 26a+26b+26c)	b	135.05	
27. Targets (value from line 26d)	b	135.05	
28. Environmental Threat Score ([lines 22 x 25 x 27]/82,500) subject to a maximum of 60	60	60	60

SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORE FOR A WATERSHED

29. Watershed Score (c) (lines 13+21+28) subject to a maximum of 100	100	100
30. Component Score (c) (highest score from line 29 for all watersheds evaluated, subject to a maximum of 100)	100	100

"a" = maximum value applicable.
 "b" = maximum value not applicable.
 "c" = do not round to nearest integer.
 NS = not scored.

NOTES TO THE READER

Laboratory Analysis - The surface water samples were analyzed for Target Analyte List (TAL) metals through the EPA Contract Laboratory Program (CLP) according to CLP Statement of Work (SOW) ILMO 4.0. The sediment samples were analyzed for TAL metals by a procured laboratory under a Delivery of Analytical Service (DAS) Work assignment in accordance with the CLP ILMO 4.0 SOW, as modified by technical specification S99-RAC1-108. The CLP Method ILMO 4.0 was modified to compensate for the low percentage of solids (high percentage of moisture) in the samples. Additionally, the method had a provision for low sample pH and a high concentration of metals. The source samples were analyzed for TAL metals by a DAS laboratory according to EPA SW-846 Methods 3010/3050/6010 and 7470/7471 and for cyanide through the EPA CLP ILMO 4.0 SOW.

Contract Required Detection Limit (CRDL)

Water Samples - The CRDL was used as the minimal sample reporting limit for each metal analyzed [15, p. 2].

Sample Quantitation Limit (SQL) - SQLs presented in this HRS package were determined accordingly:

Sediment Samples - The SQL (converted from micrograms per liter ($\mu\text{g/L}$) to milligrams per kilogram (mg/kg)) corrected by the percent solids and the amount of sample analyzed was used as the minimal sample reporting limit or SQL for each metal analyzed. An example SQL calculation has been provided [55, pp. 1-2].

Reference Citations - All reference citations used to document the HRS score utilize the following conventions:

- [20] = Single reference No. 20 (all references cited by number)
- [2; 4; 7] = Multiple references including references No. 2, 4, and 7
- [30-32] = Multiple references including references No. 30, 31, and 32
- p. = Single page [p. 5 or p. 2-3]
- pp. = Multiple pages [pp. 5, 7, or pp. 9-11, or pp. 2-3 to 2-8]
- “;” = Next reference
- Reserved = Reference Number not used
- Att. = Attachment
- App. = Appendix
- Tab. = Table
- Fig. = Figure
- Vol. = Volume
- NS = Not Scored

For example: Mine elevations range from approximately 1,640 feet above mean sea level (MSL), at the southern mine, to approximately 1,965 feet above MSL, at the summit of Pike Hill (near the northern mine) [4; 43, p. 3].

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SOURCE DESCRIPTION**2.2 Source Characterization**

Number of the source: 1

Name and description of the source: Northern Mine - Tailings Piles (Piles)

Source 1 represents two piles of tailings, Tailings Pile No. 1 & No. 2, that were generated by mining, milling, and ore processes at the Northern Mine (Figure 2). Tailings Pile No. 1 and Tailings Pile No. 2 were evaluated as one source because they're both located at the northern mine and consist of similar coarse and fine-grained materials with rock fragments [18, pp. 4, 5; 26, p. 6]. Additionally, analytical results indicate that samples from the two tailings piles are composed of similar hazardous substances [45, pp. 18, 21, 22; 48, pp. 20-21]. Collectively, the two piles contain approximately 16,700 tons of mine tailings [18, pp. 4-5; 53, p. 3]. Pile No. 1 encompasses approximately 167,367 square feet, and Pile No. 2 encompasses approximately 42,195 square feet [28; 29]. Both tailings piles are brownish-orange in color, with very little vegetative growth on the surface [25, p. 4; 26, p. 8]. Blueish-white sulfate deposits were observed on Pile No. 2 [26, p. 8].

In November/December 1998, an EPA Contractor collected source samples from the two tailings piles [53, Fig. 2, p. 5]. The source samples were analyzed for TAL metals according to the EPA SW-846 Methods 3010/3050/6010 and 7470/7471 and the CLP ILMO 4.0 SOW for cyanide [48, pp. 1, 20, 21].

Location of the source, with reference to a map of the site:

Tailings piles No. 1 and 2 are located at the northern mine (Union Mine) on the north slope of the Pike Hill, at the headwaters of the Pike Hill Brook (Figures 1 & 2). Pile No. 1 is located at the end of a dirt access road and Pile No. 2 is approximately 500 feet downslope and northeast of Pile No. 1 [4; 53, Fig. 2].

Containment

Release via overland migration and/or flood:

The surfaces of the tailings piles receive runoff and are largely unvegetated. [25, p. 4; 26, p.8]. Two erosional drainage channels have been observed originating from the top of Pike Hill, continuing through the middle of Pile Nos. 1 and 2, and emptying into Pike Hill Brook [25, pp. 4,5; 43, p.6].

There is no engineered cover, liner, or functioning and maintained run-on control system, and runoff management system for this source to prevent migration of hazardous substances from the tailings piles into surface water [1, p. 51609, Tab. 4-2; 26, p. 8; 61].

Based on analytical data, there is evidence of hazardous substance migration from the tailings piles to Pike Hill Brook [48, pp. 19-21; 78, pp. 11-12; 79, pp. 5-6]. Aluminum, beryllium, cadmium, cobalt, copper, iron, lead, manganese, nickel, sodium, vanadium, and zinc were detected in Source 1 and these same metals were detected at concentrations exceeding reference criteria in either sediment and/or surface water samples collected downstream of the PPE (Figures 2 and 3) [48, pp. 19-21; 53, Fig. 2; 78, pp. 11-12; 79, pp. 5-6].

Based on the lack of containment, and due to evidence of hazardous substance migration from the source at the site, a containment factor of 10 has been assigned to Source 1 [1, p. 51609, Tab. 4-2].

2.4.1 Hazardous Substances

In November/December 1998, an EPA contractor collected nine samples from Source 1 [43, Fig. 2, pp. 6, 7]. The samples were analyzed according to the EPA SW-846 Methods 3010/3050/6010 and 7470/7471 for metals and the CLP ILM0 4.0 SOW for cyanide [47, pp. 16-17; 48, pp. 20, 21]. A Tier II data validation was performed by and EPA contractor. The inorganic data were validated according to the Region I Tiered Organic and Inorganic Data Validation Guidelines dated July 1, 1993 [47, pp. 1-17; 48, pp. 1-21].

The following table summarizes the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances associated with the tailings piles (Source 1) at the PHCM site based on analytical results.

<u>Hazardous Substance</u>	<u>Evidence (Sample No.)</u>	<u>Reference</u>
Aluminum	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Antimony	DAF03G (SS-03)	[48, p. 20]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Arsenic	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Barium	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Beryllium	DAF02G (SS-02)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
Cadmium	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]

<u>Hazardous Substance</u>	<u>Evidence (Sample No.)</u>	<u>Reference</u>
Cadmium (cont.)	DAF09G (SS-09)	[48, p. 21]
Chromium	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Cobalt	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Copper	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Cyanide	DAF05G (SS-05)	[48, p. 20]
Iron	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Lead	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Magnesium	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]

<u>Hazardous Substance</u>	<u>Evidence (Sample No.)</u>	<u>Reference</u>
Manganese	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Mercury	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Nickel	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
Potassium	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Selenium	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Silver	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]

<u>Hazardous Substance</u>	<u>Evidence (Sample No.)</u>	<u>Reference</u>
Sodium	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Vanadium	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]
Zinc	DAF01G (SS-01)	[48, p. 20]
	DAF02G (SS-02)	[48, p. 20]
	DAF03G (SS-03)	[48, p. 20]
	DAF04G (SS-04)	[48, p. 20]
	DAF05G (SS-05)	[48, p. 20]
	DAF06G (SS-06)	[48, p. 21]
	DAF07G (SS-07)	[48, p. 21]
	DAF08G (SS-08)	[48, p. 21]
	DAF09G (SS-09)	[48, p. 21]

2.4.2. Hazardous Waste Quantity

The Hazardous Waste Quantity for Source 1 was calculated based on the Area Assigned Value. The Hazardous Constituent Quantity, Hazardous Wastestream Quantity, and Volume Assigned Values were assigned a value of zero for Source 1 because insufficient information was available for scoring purposes. [1, p. 51591].

2.4.2.1.4. Area

A Global Positioning System (GPS) Unit was used to survey and delineate the surface area of the tailings piles at the northern mine [28;29]. Pile No. 1 encompasses an area of approximately 167,367 square feet [28;29]. Pile No. 2 encompasses an area of approximately 42,195 square feet [28;29].

<u>Northern Mine Tailings Piles</u>	<u>Area</u>	<u>Reference</u>
Pile No. 1	167,367 ft ²	28;29
Pile No. 2	42,195 ft ²	28;29

The total area of the source is equal to the sum of the areas of Pile No. 1 and Pile No. 2:

$$167,367 \text{ ft}^2 + 42,195 \text{ ft}^2 = 209,562 \text{ ft}^2$$

Area of source (ft²):209,562

Reference(s): 28;29

Source 1 is a pile. The area of a "pile" source, in square feet, is divided by 13 to determine the area assigned value of the source [1, p. 51591, Tab. 2-5].

$$209,562 \text{ ft}^2 / 13 = 16,120.2$$

Area Assigned Value:16,120.2

SD-Source Hazardous Waste Quantity Value
Source No.:1

2.4.2.1.5. Source Hazardous Waste Quantity Value

The Hazardous Waste Quantity for Source 1 was calculated based on the Area Assigned Value. The Hazardous Constituent Quantity, Hazardous Wastestream Quantity, and Volume Assigned Values were not scored for Source 1 because insufficient information was available [1, p. 51591].

Source Hazardous Waste Quantity Value:16,120.2

Number of the source: 2

Name and description of the source: Southern Mine - Tailings Piles (Pile)

Source 2 represents approximately three piles of mine tailings that were generated by mining, milling, and ore processes at the Southern Mine (Figure 2). Collectively, the piles contain approximately 3,300 tons of mine tailings [18, p. 4]. The largest tailings pile, Tailings Pile No. 3, encompasses approximately 6,868 square feet [18, pp. 4,5; 28; 29]. The tailings piles are brownish-orange in color, fine to coarse-grained material with very little vegetation growing on the surface of the piles [25; 26, pp. 9-10].

In November/December 1998, an EPA Contractor collected source samples from Tailings Pile No. 3 [53, Fig. 2, p. 5, Table 1]. The source samples were analyzed for TAL metals according to the EPA SW-846 Methods 3010/3050/6010 and 7470/7471 and 7470/7471 and the CLP ILM0 4.0 SOW for cyanide [47, pp. 1, 17; 48, pp. 1,21].

Location of the source, with reference to a map of the site:

Tailings Pile No. 3 and the two smaller tailings piles are located at the southern mine (Eureka Mine) on the eastern hillside of Pike Hill, approximately 1,500 feet south of the Pike Hill summit, and approximately 2,300 feet south of Source 1 (Figures 1 & 2) [4; 43, p. 7].

Containment

Release via overland migration and/or flood:

The surfaces of the tailings piles receive runoff and are largely unvegetated [25, p. 4; 26, pp. 9, 10].

There is no engineered cover, liner, or functioning and maintained runoff management system for this source to prevent migration of hazardous substances from the tailings piles to travel overland to the Unnamed Tributary and Cookville Brook [1, p. 51609, Tab. 4-2; 61].

Based on the lack of containment, a containment factor of 10 has been assigned to Source 2 [1, p. 51609, Tab. 4-2].

2.4.1 Hazardous Substances

In November/December 1998, an EPA contractor collected four samples from Tailings Pile No. 3 at Source 2 [43, Fig. 2, pp. 6, 7; 53, Table 1]. The samples were analyzed according to the EPA SW-846 Methods 3010/3050/6010 and 7470/7471 for metals and the CLP ILM0 4.0 SOW for cyanide [47, pp. 1, 17; 48, pp. 1,21]. A Tier II data validation was performed by an EPA contractor. The inorganic data were validated according to the Region I Tiered Organic and Inorganic Data Validation Guidelines dated July 1, 1993 [47, pp. 1-17; 48, pp. 1-21].

The following table summarizes the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances associated with the tailings piles (Source 2) at the PHCM site based on analytical results.

<u>Hazardous Substance</u>	<u>Evidence (Sample No.)</u>	<u>Reference</u>
Aluminum	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Antimony	DAF10G (SS-10)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 21]
Arsenic	DAF10G (SS-10)	[48, p. 20]
Barium	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Cadmium	DAF10G (SS-10)	[48, p. 20]
Chromium	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Cobalt	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Copper	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Iron	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Lead	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Magnesium	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]

<u>Hazardous Substance</u>	<u>Evidence (Sample No.)</u>	<u>Reference</u>
Manganese	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Mercury	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Nickel	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Potassium	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Selenium	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Silver	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Sodium	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Vanadium	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]
Zinc	DAF10G (SS-10)	[48, p. 20]
	DAF11G (SS-11)	[48, p. 20]
	DAF12G (SS-12)	[48, p. 20]
	DAF13G (SS-13)	[48, p. 20]

2.4.2. Hazardous Waste Quantity

The Hazardous Waste Quantity for Source 2 was calculated based on the Volume Assigned Value. The Hazardous Constituent Quantity, Hazardous Wastestream Quantity, and Area Assigned Values were assigned a value of zero for Source 2 because insufficient information was available for scoring purposes. [1, p. 51591].

A GPS Unit was used to determine and delineate the area of Tailings Pile No. 3, at the Southern Mine [28; 29]. The area of Pile No. 3 covers approximately 6,868 square feet [28; 29]. However, the area of the two smaller tailings piles were not delineated, therefore, Source 2 was scored using volume information for the Hazardous Waste Quantity.

2.4.2.1.3. Volume

There are three tailings piles located at the southern mine [26, pp. 9,10]. The piles are estimated to collectively total approximately 3,300 tons of materials [18, p. 4; 43, p. 6].

<u>Southern Mine Tailings Piles</u>	<u>Volume</u>	<u>Reference</u>
Piles	3,3000 tons	18; p. 4; 43, p. 6

Dimension of source (yd³): 3,300
Reference(s): [1, p. 51591, Tab. 2-5; 18,p.4]

The unit volume of the source in tons is converted to cubic yards (yd³):

1 ton = 1 cubic yard
3,300 tons = 3,300 cubic yards

Source 2 is a pile. The volume of a "pile" source, in cubic yards is divided by 2.5 to determine the volume assigned value of the source [1, p. 51591, Tab. 2-5].

$3,300 \text{ yd}^3 / 2.5 = 1,320$

Area Assigned Value: 1,320

SD-Source Hazardous Waste Quantity Value
Source No.:2

2.4.2.1.5. Source Hazardous Waste Quantity Value

The Hazardous Waste Quantity for Source 2 was calculated based on the Volume Assigned Value. The Hazardous Constituent Quantity, Hazardous Wastestream Quantity, and Area Assigned Values were not scored for Source 2 because insufficient information was available [1, p. 51591].

Source Hazardous Waste Quantity Value:1,320

SITE SUMMARY OF SOURCE DESCRIPTIONS

Source No.	Source Hazardous Waste Quantity Value	Ground Water	<u>Containment</u>		
			Surface Water	Gas	Air Particulate
1	16,120.2	NS	10	NS	NS
2	1,320	NS	10	NS	NS

[1, p. 51609, Tab. 4-2]

NS = Not Scored

Total Source Hazardous Waste Quantity Value = 17,440.2

Rounded to Nearest Integer = 17,440

SWOF-Surface Water Overland Flow/Flood Migration Pathway

4.1 OVERLAND/FLOOD MIGRATION COMPONENT

4.1.1.1 DEFINITION OF HAZARDOUS SUBSTANCE MIGRATION PATH FOR OVERLAND/FLOOD COMPONENT

The Pike Hill Copper Mine is located within the Connecticut River Drainage Basin [4-9]. PHCM is located on Pike Hill, a large hill in a rural and forested area along the eastern flank of the Green Mountains [4; 8; 18, p. 2; 43, p. 3]. Runoff at the PHCM site flows into surface water from the source areas at the PHCM site either directly by overland runoff or via runoff from precipitation that infiltrates and leaches through the tailings piles and discharges as seeps [4; 25, pp. 4, 5; 26, pp. 7-8]. There are two probable points of entry (PPE) locations associated with the sources at the PHCM site (Figure 2). Runoff from the northern mine flows into Pike Hill Brook at PPE1, and runoff from the southern mine flows into the unnamed tributary at PPE2 [4; 25, pp. 4, 5; 26, pp. 7-8; 53, p. 9]. For HRS purposes, the PHCM is located within a single watershed because the Pike Hill Brook and unnamed stream both flow into the Waits River within the 15-mile target distance limit for sources at the site [1, p. 51605].

PPE1 - Source 1

Two erosional drainage channels have been observed originating from the top of Pike Hill, continuing through the middle of Pile Nos. 1 and 2, and emptying into Pike Hill Brook [25, pp. 4, 5; 43, p. 6]. PPE1 is located at the point where Pike Hill Brook begins flowing as a perennial stream (Figure 2) [26, p. 7; 43, p. 20]. During a June 1999 site reconnaissance, there was steady surface water flow from Pile No. 1 to Pile No. 2, into Pike Hill Brook, approximately 1,000 feet northeast of Pile No. 1 [25, p. 4; 26, p. 8; 53, p. 8]. Surface water flow was fed by seeps flowing from the tailings piles [59].

Pike Hill Brook is a perennial stream and the headwaters originate in Pile No. 2 [26, pp. 7-8; 43, p. 20, 22, 30]. From the PPE, Pike Hill Brook flows east approximately 4.5 miles where it discharges into the Waits River [6; 7; 30-35]. The Waits River flows southeast approximately 10 miles and empties into the Connecticut River [6; 7; 30-35]. The 15-mile surface water target distance limit (TDL) from the PPE is approximately 0.5 miles downstream of the Waits River and Connecticut River confluence (Figure 3) [6-7; 30-35].

PPE2 - Source 2

Overland runoff from the tailings piles at the southern mine enters the unnamed tributary at PPE2. From PPE2, the unnamed tributary, a perennial stream, flows approximately 0.8 miles south to Cookville Brook (Figures 2 and 3) [4]. The Cookville Brook flows approximately 3.2 miles east into the South Branch Waits River [4; 8-9]. The South Branch Waits River flows approximately 5 miles east into the Waits River [4; 8-9]. The 15 mile surface water target distance limit (TDL2) from PPE2 is approximately 6 miles downstream of the convergence of the Waits River and the South Branch Waits River (Figure 3) [8-9].

The two surface water pathways converge in the Waits River approximately 7 miles downstream of PPE1 and 8 miles downstream of PPE2 (Figures 2 and 3) [4; 8-9]. Because the hazardous substance migration paths for both sources overlap within the target distance limit (TDL), the in-water segments are evaluated as a single watershed [3, p. 222; 6-7]. The TDL for the watershed is TDL1 because it is 15 miles downstream from the farthest downstream PPE [3, p. 212].

The flow rates for Pike Hill Brook and the unnamed tributary are approximately 5.99 and 0.92 cubic feet per second (cfs), respectively [64]. For the purposes of the HRS scoring package, these surface water bodies are considered to be minimal streams (flow rate < 10 cfs) [1, p. 51613, Table 4-13].

Cookville Brook and South Branch Waits River are both classified as small to moderate streams because their flow rates are approximately 53.15 cfs and 58.25 cfs, respectively [1, p. 51613, Table 4-13; 75].

The Waits River has a flow rate between 100 and 1,000 cfs [74]. For purposes of this

HRS scoring package, the Waits River is considered a moderate to large stream [1, p. 51613, Tab. 4-13]. The mean annual flow rate of the Connecticut River, at the Waits River confluence, is approximately 4,196 cfs [64; 66-71]. For the purposes of the HRS scoring package, the Connecticut River is considered a large stream to river [1, p. 51613, Tab. 4-13]. The flow rate calculations were based on a conversion factor of 1.33 cfs per square mile of drainage basin area for rivers in the eastern portion of Orange County, Vermont, [72; 73, p. 2].

No known drinking water intakes are located along the 15-mile downstream surface water pathways [24; 38-40; 49; 76].

Approximately 3.8 miles of wetland frontage exists along the 15-mile downstream surface water pathway (Figure 3) [30-35; 51; 80].

The Eastern small-footed bat (*Myotis leibii*), identified within a 0.25-mile of the PHCM site is listed as a state-threatened species [19]. According to the State of Vermont Department of Fish and Wildlife, the bat's habitat is known to be in, and generally forages around, surface water bodies in the immediate vicinity of the PHCM site [10]. No other Federal or State-threatened or endangered species are known to exist along the 15-mile downstream surface water pathway [19; 21].

In October 1999, an EPA contractor conducted sampling activities at the Pike Hill Copper Mine. Surface water and sediment samples were collected and analyzed for total metals (Figure 2). Analytical results of sediment and surface water samples collected from Pike Hill Brook and Waits River indicate the presence of hazardous substances associated with sources on the site [78, pp. 1-13; 79, pp. 1-6]. Surface water analytical results document an observed release attributable to the site for aluminum, cobalt, copper, iron, manganese, nickel, sodium, and zinc [79, pp. 5-6]. Sediment sample analytical results also document an observed release attributable to the site for beryllium, cadmium, cobalt, copper, iron, lead, manganese, nickel, sodium, vanadium, and zinc [78, pp. 11-12].

4.1.2.1 LIKELIHOOD OF RELEASE

An observed release was established by chemical analysis for both sediment and surface water samples. Documentation is discussed below.

4.1.2.1.1 Observed Release

Chemical Analysis - Sediment Samples

Sediment samples used to establish an observed release by chemical analysis were collected in October 1999 by an EPA contractor and analyzed for total metals [26, pp. 31-44; 78, pp. 11-12].

- Background Concentration (Sediment)

Background sediment samples were collected in Cookville Brook and the Waits River (Figure 2) [26, pp. 31-38, 43, 44]. The headwaters of Pike Hill Brook begin in Tailings Pile No. 2 (Source 1). Based on this, an upstream sample could not be collected from Pike Hill Brook [4]. Therefore, background samples 03-SD-07 and 03-SD-08 were collected from Cookville Brook. This stream was selected because it had a flow rate similar to portions of Pike Hill Brook and did not appear to be impacted from historical mining operations [57]. The background samples were collected approximately 100 and 15 feet, respectively, upstream of the unnamed tributary/Cookville Brook confluence (Figure 2) [26, p. 44]. These background sample results were compared to the Pike Hill Brook analytical release sample results (Figure 2).

Background sediment samples 03-SD-04 and 03-SD-03 were collected in the Waits River, 100 and 120 feet, respectively, upstream of the Pike Hill Brook/Waits River confluence [26, pp. 37, 38]. These background sample results were compared to the Waits River release sample analytical results (Figure 2).

Two background sample locations were selected to characterize the variability of naturally occurring metals. For each analyte, the sediment sample with the highest concentration for that pair was used to establish background concentrations.

<u>Sample ID</u>	<u>Sampling Location</u>	<u>Depth</u>	<u>Date</u>	<u>Reference</u>
DO0392	03-SD-08 Cookville Brook	0-6 in	10/5/99	[26, p. 44]
D00393	03-SD-07 Cookville Brook	0-6 in	10/5/99	[26, p. 44]
D00396	03-SD-04 Waits River	0-6 in	10/5/99	[26, p. 37]
D00397	03-SD-03 Waits River	0-6 in	10/5/99	[26, p. 38]

Sample ID	Hazardous Substance	Concentration (mg/kg)	Adj. Concen. (mg/kg)	SQL (mg/kg)	Reference
D00392 (03-SD-08)	Aluminum	4,940		4.7	[78,p.11;*]
	Antimony	ND		0.70	[78,p.11;*]
	Arsenic	ND		1.0	[78,p.11;*]
	Barium	28.1		0.19	[78,p.11;*]
	Beryllium	ND		0.19	[78,p.11;*]
	Cadmium	ND		0.068	[78,p.11;*]
	Chromium	12.8 J		0.070	[78,p.11;*]
	Cobalt	ND		3.4	[78,p.11;*]
	Copper	ND		3.2	[78,p.11;*]
	Iron	5,620		0.93	[78,p.11;*]
	Lead	4.2 J		0.47	[78,p.11;*]
	Magnesium	3,200		1.2	[78,p.11;*]
	Manganese	199 J ¹	(246.76)	0.21	[78,p.11;*]
	Mercury	0.11 J		0.052	[78,p.11;*]
	Nickel	7.6		0.16	[78,p.11;*]
	Potassium	1,100		17.3	[78,p.11;*]
	Silver	ND		0.61	[78,p.11;*]
	Sodium	ND		82.0	[78,p.11;*]
	Thallium	ND		0.70	[78,p.11;*]
	Vanadium	10.7		0.093	[78,p.11;*]
	Zinc	16.8		2.10	[78,p.11;*]
D00393 (03-SD-07)	Aluminum	3,050		4.4	[78,p.11;*]
	Antimony	ND		0.66	[78,p.11;*]
	Arsenic	ND		0.88	[78,p.11;*]
	Barium	18.0		0.18	[78,p.11;*]
	Beryllium	ND		0.13	[78,p.11;*]
	Cadmium	ND		0.093	[78,p.11;*]
	Chromium	7.1 J		0.066	[78,p.11;*]
	Cobalt	ND		1.7	[78,p.11;*]
	Copper	ND		2.4	[78,p.11;*]
	Iron	3,520		0.88	[78,p.11;*]
	Lead	ND		2.4	[78,p.11;*]
	Magnesium	1,830		1.1	[78,p.11;*]
	Manganese	173 J		0.20	[78,p.11;*]
	Mercury	ND		0.044	[78,p.11;*]
	Nickel	3.6		0.15	[78,p.11;*]
	Potassium	680		16.3	[78,p.11;*]
	Silver	ND		0.46	[78,p.11;*]
	Sodium	ND		77.4	[78,p.11;*]
	Thallium	ND		1.3	[78,p.11;*]
	Vanadium	7.7		0.088	[78,p.11;*]
	Zinc	ND		11.8	[78,p.11;*]
D00396 (03-SD-04)	Aluminum	2,840		4.9	[78,p.11;*]
	Antimony	ND		0.74	[78,p.11;*]
	Arsenic	ND		0.99	[78,p.11;*]
	Barium	12.8		0.20	[78,p.11;*]
	Beryllium	ND		0.16	[78,p.11;*]
	Cadmium	ND		0.049	[78,p.11;*]
	Chromium	6.2		0.074	[78,p.11;*]
	Cobalt	ND		1.9	[78,p.11;*]
	Copper	ND		2.4	[78,p.11;*]
	Iron	4,430		0.98	[78,p.11;*]
	Lead	ND		2.8	[78,p.11;*]
	Magnesium	1,600		1.2	[78,p.11;*]
	Manganese	175 J		0.22	[78,p.11;*]
	Mercury	ND		0.046	[78,p.11;*]

Sample ID	Hazardous Substance	Concentration (mg/kg)	Adj. Concen. (mg/kg)	SQL (mg/kg)	Reference
D00396	Nickel	4.3		0.17	[78,p.11;*]
(03-SD-04)	Potassium	405		18.2	[78,p.11;*]
(cont.)	Silver	ND		0.54	[78,p.11;*]
	Sodium	ND		86.5	[78,p.11;*]
	Thallium	ND		0.74	[78,p.11;*]
	Vanadium	7.0		0.10	[78,p.11;*]
	Zinc	13.6 J		2.2	[78,p.11;*]
D00397	Aluminum	2,320		4.8	[78,p.11;*]
(03-SD-03)	Antimony	0.71 J		0.71	[78,p.11;*]
	Arsenic	ND		0.95	[78,p.11;*]
	Barium	ND		11.1	[78,p.11;*]
	Beryllium	ND		0.11	[78,p.11;*]
	Cadmium	ND		0.063	[78,p.11;*]
	Chromium	4.9 J		0.071	[78,p.11;*]
	Cobalt	ND		1.8	[78,p.11;*]
	Copper	ND		2.5	[78,p.11;*]
	Iron	4,050		0.95	[78,p.11;*]
	Lead	ND		2.6	[78,p.11;*]
	Magnesium	1,410		1.1	[78,p.11;*]
	Manganese	139 J		0.21	[78,p.11;*]
	Mercury	ND		0.044	[78,p.11;*]
	Nickel	4.1		0.17	[78,p.11;*]
	Potassium	468		17.6	[78,p.11;*]
	Silver	ND		0.41	[78,p.11;*]
	Sodium	ND		83.3	[78,p.11;*]
	Thallium	ND		0.71	[78,p.11;*]
	Vanadium	5.5		0.095	[78,p.11;*]
	Zinc	13.8 J		2.2	[78,p.11;*]

ND = Not detected. The chemical was analyzed for and was not detected.

mg/kg = milligrams per kilogram

J = Quantitation approximate (data accepted for use as qualified). No adjustment factors were applied.

J¹ = Adjustment factor was applied to the AJ@ qualified data that was estimated as a result of poor matrix spike recovery (low bias) [41].

() = Adjusted value

* = Additional references [15; 41; 55; 77]

R = Rejected data

SQL = Sample Quantitation Limit

Adj. Concen. = Adjusted Concentration

- Contaminated Samples (sediment)

Sediment samples 03-SD-02 and 03-SD-01 were collected in Pike Hill Brook, approximately 4.5 miles and 3 miles downstream from the PPE, respectively. Rocks and sediment at location 03-SD-01 were stained orange-brown [26, p. 41]. The same orange-brown staining is visible throughout Pile Nos. 1 and 2 [26, pp. 6-8]. Sediment sample 03-SD-02 was collected in Pike Hill Brook approximately 20 feet upstream from the Waits River/Pike Hill Brook confluence (Figure 2) [26, p. 39]. Sediment sample 03-SD-DUP-01 represents a field duplicate sample of 03-SD-01 collected for QA/QC purposes.

Sediment samples 03-SD-05 and 03-SD-06 were collected in the Waits River to document actual contamination in a fishery. Sediment sample 03-SD-05 was collected in the Waits River at the confluence with Pike Hill Brook; sediment sample 03-SD-06 was collected approximately 30 feet downstream of the Waits River/Pike Hill Brook confluence [26, pp. 32-33, 36].

These samples were collected in successive order from downstream to upstream locations during the sampling event, and are considered similar to sediment samples from background locations [26, pp. 32-33, 36, 39-41]. All samples were collected from the same approximate depth and environmental setting. The soil type and organic content at each location were similar. All samples appeared to consist of a grayish-brown fine-grained to medium-grained sand [26, pp. 33, 36].

<u>Sample ID</u>	<u>Sampling Location</u>	<u>Depth</u>	<u>Date</u>	<u>Reference</u>
D00394	03-SD-06 Waits River	0-6 in.	10/5/99	[26, pp. 32-33]
D00395	03-SD-05 Waits River	0-6 in.	10/5/99	[26, pp. 33-36]
D00398	03-SD-02 Pike Hill Brook	0-6 in.	10/5/99	[26, p. 39]
D00399	03-SD-01 Pike Hill Brook	0-6 in.	10/5/99	[26, pp. 40-41]
D00400	03-SD-DUP-01 Pike Hill Brook	0-6 in.	10/5/99	[26, pp. 40-41]

Sample ID	Hazardous Substance	Concentration (mg/kg)	Adj. Concn. (mg/kg)	Sample Quantitation Limit (mg/kg)	Reference
D00394 (03-SD-06)	Cobalt	10.6	(2.85)	0.091	[78,p.11;*]
	Copper	22.3		0.46	[78,p.11;*]
	Lead	4.1 J ¹		0.46	[78,p.11;*]
	Zinc	64.0		2.0	[78,p.11;*]
D00395 (03-SD-05)	Cobalt	10.0		0.081	[78,p.11;*]
	Copper	22.4		0.40	[78,p.11;*]
	Zinc	58.8		1.8	[78,p.11;*]
D00398 (03-SD-02)	Cobalt	25.8		0.081	[78,p.11;*]
	Copper	77.6		0.40	[78,p.11;*]
	Sodium	252		70.8	[78,p.11;*]
	Zinc	179		1.8	[78,p.11;*]
D00399 (03-SD-01)	Beryllium	0.52	(6.8)	0.017	[78,p.11;*]
	Cadmium	9.6 J ¹		0.034	[78,p.11;*]
	Cobalt	463		0.069	[78,p.11;*]
	Copper	3,790		0.34	[78,p.11;*]
	Iron	61,700		0.69	[78,p.11;*]
	Lead	17.5 J ¹		0.34	[78,p.11;*]
	Manganese	2,580 J		0.15	[78,p.11;*]
	Sodium	3,280		60.4	[78,p.11;*]
	Zinc	1,580		1.5	[78,p.11;*]
D00400 (03-SD-DUP-01)	Beryllium	0.59	(7.02)	0.017	[78,p.12;*]
	Cadmium	9.9 J ¹		0.035	[78,p.12;*]
	Cobalt	468		0.070	[78,p.12;*]
	Copper	3,910		0.35	[78,p.12;*]
	Iron	64,700		0.70	[78,p.12;*]
	Manganese	2,630 J		0.12	[78,p.12;*]
	Sodium	3,380		61.1	[78,p.12;*]
	Zinc	1,640		1.6	[78,p.12;*]

mg/kg = milligrams per kilogram

* = Additional references [15; 41; 55; 77]

J = Quantitation approximate (data accepted for use as qualified). No adjustment factors were applied.

ND = Not detected. The chemical was analyzed for and was not detected.

J¹ = Adjustment factors were applied to the AJ@ qualified data that was estimated as a result of iron interference, and/or high matrix spike recovery.

() = Adjusted value

Adj. Concn. = Adjusted Concentration

Chemical Analysis - Surface Water Samples

Surface water samples used to establish an observed release by chemical analysis were collected in October 1999 by an EPA contractor and analyzed for total metals [26, pp. 31-44; 78, pp. 11-12].

- Background Concentration (Surface Water)

Background surface water samples were collected from the streambeds of Cookville Brook and the Waits River (Figure 2) [26, pp. 37, 38, 43]. Release surface water samples were collected from the streambeds of Pike Hill Brook and the Waits River [26, pp. 32-36, 39-41].

Pike Hill Brook originates at Tailings Pile No. 2 (Source 1), therefore, background surface water samples were not collected in Pike Hill Brook (Figure 2) [4]. The brook was visually impacted by the tailings pile from which it flows [26, pp. 6-7; 57]. Background surface water samples 03-SW-08 (MALF11) and 03-SW-07 (MALF12) were collected in Cookville Brook, approximately 15 and 100 feet, respectively, upstream of the unnamed tributary/Cookville Brook confluence [26, pp. 43-44]. These background sample results were compared to the Pike Hill Brook analytical release sample results (Figure 2).

Background surface water samples 03-SW-04 (MALF15) and 03-SW-03 (MALF16) were collected in the Waits River, approximately 100 and 120 feet, respectively, upstream of the Pike Hill Brook/Waits River confluence [26, pp. 37-38]. These background sample results were compared to the Waits River release sample analytical results (Figure 2).

Two background sample locations were selected to characterize the variability of naturally occurring metals [79]. For each analyte, the surface water sample with the highest concentration for that pair was used to establish background concentrations.

<u>Sample ID</u>	<u>Sampling Location</u>	<u>Depth</u>	<u>Date</u>	<u>Reference</u>
MALF11	03-SW-08 Cookville Brook	0-2 in.	10/5/99	[26, p. 44]
MALF12	03-SW-07 Cookville Brook	0-2 in.	10/5/99	[26, p. 44]
MALF15	03-SW-04 Waits River	0-2 in.	10/5/99	[26, p. 37]
MALF16	03-SW-03 Waits River	0-2 in.	10/5/99	[26, p. 38]

<u>Sample ID</u>	<u>Hazardous Substance</u>	<u>Concentration</u> (: g/l)	<u>CRDL</u> (: g/l)	<u>Reference</u>
MALF11	Aluminum	ND ¹	200	[79, p. 5; *]
(03-SW-08)	Antimony	ND	60	[79, p. 5; *]
	Arsenic	ND	10	[79, p. 5; *]
	Barium	ND ¹	200	[79, p. 5; *]
	Beryllium	ND	5	[79, p. 5; *]
	Cadmium	ND	5	[79, p. 5; *]
	Chromium	ND	10	[79, p. 5; *]
	Cobalt	ND	50	[79, p. 5; *]
	Copper	ND ¹	25	[79, p. 5; *]
	Iron	ND ¹	100	[79, p. 5; *]
	Lead	ND	3	[79, p. 5; *]
	Magnesium	ND ¹	5,000	[79, p. 5; *]
	Manganese	16.2	15	[79, p. 5; *]
	Mercury	ND	0.20	[79, p. 5; *]
	Nickel	ND	40	[79, p. 5; *]
	Potassium	ND ¹	5,000	[79, p. 5; *]

Sample ID	Hazardous Substance	Concentration (: g/l)	CRDL (: g/l)	Reference
	Selenium	ND	5	[79, p. 5; *]
	Silver	ND	10	[79, p. 5; *]
	Sodium	ND ¹	5,000	[79, p. 5; *]
	Thallium	ND	10	[79, p. 5; *]
	Vanadium	ND	50	[79, p. 5; *]
	Zinc	ND ¹	20	[79, p. 5; *]
MALF12 (03-SW-07)	Aluminum	ND ¹	200	[79, p. 5; *]
	Antimony	ND	60	[79, p. 5; *]
	Arsenic	ND	10	[79, p. 5; *]
	Barium	ND ¹	200	[79, p. 5; *]
	Beryllium	ND	5	[79, p. 5; *]
	Cadmium	ND	5	[79, p. 5; *]
	Chromium	ND	10	[79, p. 5; *]
	Cobalt	ND	50	[79, p. 5; *]
	Copper	ND ¹	25	[79, p. 5; *]
	Iron	ND ¹	100	[79, p. 5; *]
	Magnesium	ND ¹	5,000	[79, p. 5; *]
	Manganese	17.0	15	[79, p. 5; *]
	Mercury	ND	0.20	[79, p. 5; *]
	Nickel	ND	40	[79, p. 5; *]
	Potassium	ND ¹	5,000	[79, p. 5; *]
	Selenium	ND	5	[79, p. 5; *]
	Silver	ND	10	[79, p. 5; *]
	Sodium	ND ¹	5,000	[79, p. 5; *]
	Thallium	ND	10	[79, p. 5; *]
	Vanadium	ND	50	[79, p. 5; *]
	Zinc	ND	20	[79, p. 5; *]
MALF15 (03-SW-04)	Aluminum	ND ¹	200	[79, p. 5; *]
	Antimony	ND	60	[79, p. 5; *]
	Arsenic	ND	10	[79, p. 5; *]
	Barium	ND ¹	200	[79, p. 5; *]
	Beryllium	ND	5	[79, p. 5; *]
	Cadmium	ND	5	[79, p. 5; *]
	Chromium	ND	10	[79, p. 5; *]
	Cobalt	ND	50	[79, p. 5; *]
	Copper	ND ¹	25	[79, p. 5; *]
	Iron	ND	100	[79, p. 5; *]
	Lead	ND	3	[79, p. 5; *]
	Magnesium	ND ¹	5,000	[79, p. 5; *]
	Manganese	ND ¹	15	[79, p. 5; *]
	Mercury	ND	0.20	[79, p. 5; *]
	Nickel	ND	40	[79, p. 5; *]
	Potassium	ND ¹	5,000	[79, p. 5; *]
	Selenium	ND	5	[79, p. 5; *]
	Silver*	ND ¹	10	[79, p. 5; *]
	Sodium	ND ¹	5,000	[79, p. 5; *]
	Thallium	ND	10	[79, p. 5; *]
	Vanadium	ND	50	[79, p. 5; *]
	Zinc	ND ¹	20	[79, p. 5; *]
MALF16 (03-SW-03)	Aluminum	ND ¹	200	[79, p. 5; *]
	Antimony	ND	60	[79, p. 5; *]
	Arsenic	ND	10	[79, p. 5; *]
	Barium	ND ¹	200	[79, p. 5; *]
	Beryllium	ND	5	[79, p. 5; *]
	Cadmium	ND	5	[79, p. 5; *]
	Chromium	ND	10	[79, p. 5; *]
	Cobalt	ND	50	[79, p. 5; *]
	Copper	ND ¹	25	[79, p. 5; *]
	Iron	ND	100	[79, p. 5; *]
	Lead	ND	3	[79, p. 5; *]

Sample ID	Hazardous Substance	Concentration (: g/l)	CRDL (: g/l)	Reference
	Magnesium	ND ¹	5,000	[79, p. 5; *]
	Manganese	ND ¹	15	[79, p. 5; *]
	Mercury	ND	0.20	[79, p. 5; *]
	Nickel	ND	40	[79, p. 5; *]
	Potassium	ND ¹	5,000	[79, p. 5; *]
	Selenium	ND	5	[79, p. 5; *]
	Silver	ND ¹	10	[79, p. 5; *]
	Sodium	ND ¹	5,000	[79, p. 5; *]
	Thallium	ND	10	[79, p. 5; *]
	Vanadium	ND	50	[79, p. 5; *]
	Zinc	ND	20	[79, p. 5; *]

CRDL = Contract Required Detection Limit

ND = Not detected. The chemical was analyzed for and was not detected.

Fg/l = micrograms per liter

ND¹ = The sample concentration is less than the CRDL.

* = Additional references [15]

- Contaminated Samples (surface water)

Surface water samples 03-SW-02 (MALF17) and 03-SD-01 (MALF18) were collected in Pike Hill Brook, approximately 4.5 miles and 3 miles downstream from the PPE, respectively. Surface water at location 03-SD-01/03-SW-01 was stained orange-brown [26, p. 41]. The same orange-brown staining was also visible throughout Pile Nos. 1 and 2 [26, pp. 6-8]. Surface water sample 03-SW-02 was collected approximately 20 feet upstream from the Waits River/Pike Hill Brook confluence (Figure 2) [26, p. 39]. Surface water sample SW-DUP-01 (MALF19) represents a field duplicate sample collected for QA/QC purposes.

Surface water samples 03-SW-05 (MALF14) and 03-SW-06 (MALF13) were collected in the Waits River to document actual contamination in a fishery. 03-SW-05 was collected at the confluence of the Waits River and Pike Hill Brook; 03-SW-06 was collected approximately 30 feet downstream of the Waits River/Pike Hill Brook confluence [26, pp. 32-33, 36].

The contaminated surface water samples and background surface water samples were collected under similar meteorological conditions, from sections of the stream with similar environmental settings and flow rates. In addition, a direct-dip method was used to collect both background and release surface water samples. All surface water samples were analyzed similarly, for total metals using the same method [26, pp. 32-33, 36-41].

Sample ID	Sampling Location	Depth	Date	Reference
MALF13	03-SW-06 Waits River	0-2 in.	10/5/99	[26, pp. 32-33]
MALF14	03-SW-05 Waits River	0-2 in.	10/5/99	[26, pp. 33, 36]
MALF17	03-SW-02 Pike Hill Brook	0-2 in.	10/5/99	[26, p. 39]
MALF18	03-SW-01 Pike Hill Brook	0-2 in.	10/5/99	[26, pp. 40-41]
MALF19	03-SW-DUP-01 Pike Hill Brook	0-2 in.	10/5/99	[26, pp. 40-41]

Sample ID	Hazardous Substance	Concentration (: g/l)	CRDL (: g/l)	Reference
MALF13	Iron	131	100	[79, p. 5; *]
(03-SW-06)	Manganese	28.2	15	[79, p. 5; *]
MALF14	Copper	27.6	25	[79, p. 5; *]
(03-SW-05)	Iron	333	100	[79, p. 5; *]
	Manganese	82.6	15	[79, p. 5; *]
	Zinc	36.2	20	[79, p. 5; *]
MALF17	Copper	29.1	25	[79, p. 5; *]
(03-SW-02)	Iron	352	100	[79, p. 5; *]
	Manganese	85.9	15	[79, p. 5; *]
	Sodium	5,790	5,000	[79, p. 5; *]
	Zinc	36.6	20	[79, p. 5; *]
MALF18	Aluminum	1,510	200	[79, p. 5; *]
(03-SW-01)	Cobalt	87.0	50	[79, p. 5; *]
	Copper	790	25	[79, p. 5; *]
	Iron	3,900	100	[79, p. 5; *]
	Manganese	449	15	[79, p. 5; *]
	Zinc	884	20	[79, p. 5; *]
MALF19	Aluminum	1,380	200	[79, p. 6; *]
(03-SW-DUP-01)	Cobalt	86.0	50	[79, p. 6; *]
	Copper	747	25	[79, p. 6; *]
	Iron	3,470	100	[79, p. 6; *]
	Manganese	452	15	[79, p. 6; *]
	Zinc	883	20	[79, p. 6; *]

CRDL = Contract Required Detection Limit

: g/l = micrograms per liter

* = Additional references [15; 41; 77]

Attribution:

Source 1 consists of two tailings piles located on the eastern slope of the northern mine. The tailings piles are the result of copper mining operations that occurred at Pike Hill Copper Mine between 1854 and 1919. There are approximately 16,700 tons of tailings [53, p. 3]. The tailings are colored brownish-orange, and sustain very little vegetative growth [25, p. 4; 26 p. 8].

Analytical results of source samples document the presence of hazardous substances [53, pp. 11-12]. The metals detected include: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, vanadium, and zinc [48, pp. 19-21]. The

following metals were detected in sediment and surface water samples from Pike Hill Brook and/or Waits River at concentrations that meet observed release criteria: aluminum, beryllium, cadmium, cobalt, copper, iron, lead, manganese, sodium, vanadium, and zinc (Figure 2) [78, pp. 11-12; 79, pp. 5-6]. Therefore, hazardous substance migration, via overland flow, extends from the tailings piles to Pike Hill Brook to the Waits River.

During an EPA contractor site visit in June 1999, surface water was observed flowing from Tailings Pile Nos. 1 and 2, and discharging into Pike Hill Brook [25, p. 5; 26, pp. 7-8; 61]. These piles are uncovered and exposed to weathering processes [26, p. 8]. As surface water flows over the oxidized, sulfide-rich minerals within the tailings, sulfuric acid is produced and hydrogen ions are released, thus lowering the pH of the tailings. Consequently, metals and sulfides within the piles are leached and acid mine drainage is produced [54, p. 8]. This drainage enters Pike Hill Brook and carries dissolved metal concentrations to the Waits River [26, pp. 7-8, 34; 54, p. 8]. The brownish-orange staining in the sediment in Pike Hill Brook, similar to the staining on Source 1, provides visual evidence of the effects of acid mine drainage [26, p. 6]. No alternative anthropogenic sources of metals contamination to the surface water pathway have been identified in this area.

Hazardous Substances Released: (Sediment and surface water samples) Aluminum, beryllium, cadmium, cobalt, copper, iron, lead, manganese, sodium, and zinc [78, pp. 11-12; 79, pp. 5-6].

=====

Observed Release Factor Value: 550

4.1.2.1.2 POTENTIAL TO RELEASE

The overland migration pathway for Source 1 was scored based on an observed release to the sediments and surface water of Pike Hill Brook and Waits River. Therefore, the potential to release was not evaluated for Source 2.

=====

Containment Factor Value: NS

4.1.2.2 WASTE CHARACTERISTICS

4.1.2.2.1 Toxicity/Persistence

The Toxicity Factor Values and the Persistence Factor Values are assigned to the hazardous substances associated with the sources and releases at the site based on values presented in the Superfund Chemical Data Matrix (SCDM) [2].

Hazardous Substance	Source No.	Toxicity Factor Value	Persistence Factor Value	Toxicity/Persistence Factor Value (Table 4-12)	Reference
Aluminum	1	NL	1.0	<>	[2,p.BI-1]
Antimony	1	10,000	1.0	10,000	[2,p.BI-1]
Arsenic	1	10,000	1.0	10,000	[2,p.BI-1]
Barium	1	10,000	1.0	10,000	[2,p.BI-1]
Beryllium	1	10,000	1.0	10,000	[2,p.BI-2]
Cadmium	1	10,000	1.0	10,000	[2,p.BI-2]
Chromium	1	10,000	1.0	10,000	[2,p.BI-3]
Cobalt	1	10	1.0	10	[2,p.BI-3]
Copper	1	NL	1.0	<>	[2,p.BI-3]
Cyanide	1	100	1.0	100	[2,p.BI-4]
Iron	1	1.0	1.0	1.0	[2,p.BI-8]
Lead	1	10,000	1.0	10,000	[2,p.BI-8]
Magnesium	1	NL	NL	<>	
Manganese	1	10,000	1.0	10,000	[2,p.BI-8]
Mercury	1	10,000	1.0	10,000	[2,p.BI-8]
Nickel	1	10,000	1.0	10,000	[2,p.BI-9]
Potassium	1	NL	NL	<>	
Selenium	1	100	1.0	100	[2,p.BI-10]
Silver	1	100	1.0	100	[2,p.BI-10]
Sodium	1	NL	NL	<>	
Vanadium	1	100	1.0	100	[2,p.BI-12]
Zinc	1	10	1.0	10	[2,p.BI-12]

NL = Factor value not listed in SCDM

<> = Value not calculated because one of the factor values is not listed in SCDM

From HRS Table 4-12, a Toxicity Factor Value of 10,000 and a Persistence Factor Value of 1 are assigned a Toxicity/Persistence Factor Value of 10,000 [1, p. 51613].

The highest Toxicity/Persistence Factor Value is 10,000 for antimony, arsenic, barium, beryllium, cadmium, chromium, lead, manganese, mercury, and nickel.

=====

Toxicity/Persistence Factor Value: 10,000

4.1.2.2.2 Hazardous Waste Quantity

A Hazardous Waste Quantity is assigned to each source that has a Containment Factor Value greater than zero for the surface water pathway [1, p. 51590].

Source Number	Source Hazardous Waste Quantity Value (Section 2.4.2.1.5.)	Is source hazardous constituent quantity data complete? (yes/no)
1	16,120.2	No

Sum of values: 16,120.2

A Surface Water Pathway Hazardous Waste Quantity Value that is greater than 10,000, but less than or equal to 1,000,000, is assigned a Hazardous Waste Quantity Factor Value of 10,000 [1, p. 51591, Sect. 2.4.2.2, Table 2-6].

4.1.2.2.3 Waste Characteristics Factor Category Value

The Toxicity/Persistence Factor Value of 10,000 is multiplied by the Hazardous Waste Quantity Factor Value for the site (10,000) in order to determine the Waste Characteristics Factor Category Value, subject to a maximum value of 1E+08 [1, p. 51592, Section 2.4.3.1].

$$10,000 \times 10,000 = 1E+08$$

1E+08 is assigned a Waste Characteristic Factor category Value of 100 [1, p. 51592, Tab. 2-7].

Toxicity/persistence factor value
X hazardous waste quantity factor value: 1E+08

=====

Hazardous Waste Quantity Factor Value: 10,000
Waste Characteristics Factor Category Value: 100

4.1.2.3 DRINKING WATER TARGETS

Level I Concentrations

No known drinking water intakes are located along the 15-mile downstream pathway [24; 38-40; 49; 50; 76].

Level II Concentration

No known drinking water intakes are located along the 15-mile downstream pathway [24; 38-40; 49; 50; 76].

4.1.2.3.1 Nearest Intake

No known drinking water intakes are located along the 15-mile downstream pathway [24; 38-40; 49; 50; 76].

=====

Nearest Intake Factor Value: 0

4.1.2.3.2 **Population**

4.1.2.3.2.2 Level I Concentration

No known drinking water intakes are located along the 15-mile downstream pathway [24; 38-40; 49; 50; 76].

=====

Population Served	
by Level I Intakes: 0	Level I Population Factor Value: 0

4.1.2.3.2.3 Level II Concentration

No known drinking water intakes are located along the 15-mile downstream pathway [24; 38-40; 49; 50; 76].

=====

Level II Population Factor Value: 0

4.1.2.3.2.4 Potential Contamination

No known drinking water intakes are located along the 15-mile downstream pathway [24; 38-40; 49; 50; 76].

=====

Potential Contamination Factor Value: 0

4.1.2.3.3 Resources

The Waits River is designated for recreational purposes, including paddling and swimming, excluding drinking water use [36, pp. 18, 41]. The Connecticut River is designated for contact (i.e. swimming) and non-contact (i.e. boating) recreational uses [75].

A Resources Factor Value of 5 is assigned based on recreational uses of Waits River and Connecticut River along the surface water pathway [1, p. 51617].

=====

Resources Factor Value: 5

4.2.3.2 WASTE CHARACTERISTICS

4.1.3.2.1 Toxicity/Persistence/Bioaccumulation

The Toxicity Factor Values, the Persistence Factor Values, and the Bioaccumulation Factor Values are assigned to the hazardous substances associated with sources and releases at the site based on the Values presented in SCDM [2].

Hazardous Substance	Source No.	Toxicity Factor Value	Persistence Factor Value	Bioaccumulation Value	Toxicity/ Persistence/ Bioaccumulation Factor Value (Table 4-16)	Ref.
Aluminum	1	NL	1.0	50	<>	[2,p.BI-1]
Antimony	1	10,000	1.0	5.0	5E+04	[2,p.BI-1]
Arsenic	1	10,000	1.0	5.0	5E+04	[2,p.BI-1]
Barium	1	10,000	1.0	500	5E+06	[2,p.BI-1]
Beryllium	1	10,000	1.0	50	5E+05	[2,p.BI-2]
Cadmium	1	10,000	1.0	5,000	5E+07	[2,p.BI-2]
Chromium	1	10,000	1.0	500	5E+06	[2,p.BI-3]
Cobalt	1	10	1.0	5,000	5E+04	[2,p.BI-3]
Copper	1	NL	1.0	500	<>	[2,p.BI-3]
Cyanide	1	100	1.0	0.5	5E+01	[2,p.BI-4]
Iron	1	1.0	1.0	5,000	5E+03	[2,p.BI-8]
Lead	1	10,000	1.0	5	5E+04	[2,p.BI-8]
Magnesium	1	NL	NL	0.5	<>	
Manganese	1	10,000	1.0	50,000	5E+08	[2,p.BI-8]
Mercury	1	10,000	1.0	50,000	5E+08	[2,p.BI-8]
Nickel	1	10,000	1.0	0.5	5E+03	[2,p.BI-9]
Potassium	1	NL	NL	0.5	<>	
Selenium	1	100	1.0	50	5E+03	[2,p.BI-10]
Silver	1	100	1.0	50	5E+03	[2,p.BI-10]
Sodium	1	NL	NL	0.5	<>	
Vanadium	1	100	1.0	500	5E+04	[2,p.BI-12]
Zinc	1	10	1.0	5	5E+01	[2,p.BI-12]

NL = Not listed in SCDM

<> = Not calculated due to not listed in SCDM

=====

Toxicity/Persistence/Bioaccumulation Factor Value: 5E+08

4.1.3.2.2 Hazardous Waste Quantity

Source Number	Source Hazardous Waste Quantity Value (Section 2.4.2.1.5.)	Is source hazardous constituent quantity data complete? (yes/no)
1	16,120.2	No

Sum of values: 16,120.2

A Surface Water Pathway Hazardous Waste Quantity Value that is greater than 10,000, but less than or equal to 1,000,000, is assigned a Hazardous Waste Quantity Factor Value of 10,000 [1, p. 51591, Tab. 2-6].

4.1.3.2.3 Waste Characteristics Factor Category Value

The Toxicity/Persistence Factor Value for 10,000 (manganese and mercury) is multiplied by the Hazardous Waste Quantity Factor Value for the site (10,000), subject to a maximum value of 1E+08 [1, p. 51592, Section 2.4.3.1].

$$10,000 \times 10,000 = 1E+08$$

Toxicity/persistence factor value
X hazardous waste quantity factor value: 1E+08

The product of the Toxicity/Persistence Factor Value and the Hazardous Waste Quantity Factor Value for the watershed (1E+08) are multiplied by the Bioaccumulation Potential Factor Value (50,000), in order to determine the Waste Characteristics Factor Category Value subject to a maximum value of 1E+12 [1, p. 51620, Section 2.4.3.2].

$$1E+08 \times 50,000 = 5E+12 \text{ (exceeds maximum value; therefore, assign maximum value of } 1E+12)$$

(Toxicity/persistence x hazardous waste quantity)
X bioaccumulation potential factor value: 1E+12

From HRS Table 2-7, a Toxicity/Persistence x Hazardous Waste Quantity x Bioaccumulation Potential Factor Value of 1E+12 is assigned a Human Food Chain Threat - Waste Characteristics Factor Category Value of 1,000 [1, pp. 51592, Tab. 2-7, 51620].

=====

Hazardous Waste Quantity Assigned Value: 10,000
Waste Characteristics Factor Category Value: 1,000

4.1.3.3 HUMAN FOOD CHAIN THREAT-TARGETS

Actual Human Food Chain Contamination

The Waits River and the Connecticut River are documented fisheries within the 15-mile surface water pathway [36, pp. 10-11; 37; 42]. The Connecticut River sustains several fish species including: largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), brown bullhead (*Ictalurus nebulosus*), panfish, yellow perch (*Perca flavescens*), chain pickerel (*Esox niger*), and northern pike (*Esox lucius*) [22, pp. 402, 404, 470, 557, 559, and 578; 36, p. 10]. In the Waits River, there are brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), round trout, rainbow trout (*Salmo gairdneri*), and walleye [22, pp. 394, 396; 36, p. 11; 42].

Sediment and Surface Water Samples

In October 1999, an EPA contractor collected sediment and surface water samples from Waits River to document actual contamination in a fishery. Contaminants were detected in both sediment and surface water samples. These samples were collected in successive order from downstream to upstream locations during the sampling event, and are considered similar to samples from background locations [26, pp. 31-44].

An observed release to the surface water pathway was established by chemical analysis of sediment and surface water samples from locations 03-SD-05/SW-05 and 03-SD-06 [78, pp. 11-12; 79, p. 5].

The following sediment and surface water samples contain one or more hazardous substances with a bioaccumulation potential factor value of 500 or greater [2, pp. B-6, B-20].

Sediment

Sample ID	Approximate Distance from Probable Point of Entry	Hazardous Substance	Bioaccumulation Potential Factor Value
D00394 (03-SD-06)	5 miles	Copper Zinc	50,000 500
D00395 (03-SD-05)	4.5 miles	Copper Zinc	50,000 500

Surface Water

Sample ID	Approximate Distance from Probable Point of Entry	Hazardous Substance	Bioaccumulation Potential Factor Value
MALF14 (03-SW-05)	4.5 miles	Copper Zinc	50,000 500

Reference for BCF Values and downstream distances from PPE: [2, pp. B-6, B-20; 26, pp. 32-33, 36; 78, pp. 11-12; 79, p. 5]

Closed Fisheries

No closed fisheries were identified within the target distance limit.

Benthic Tissue

No tissue samples were collected from a human food chain organism, therefore, a Level I Concentration of actual contamination cannot be established [3, p. 299, Highlight 8-48].

Most Distant Level II Sample

Sample ID: D00394 (03-SD-06)

Distance from the probable point of entry: Approximately 5 miles (Figure 2)

Reference: [26, pp. 32-33; 78, p.11]

Level II Fisheries

<u>Identity of fishery</u>	<u>Extent of the Level II Fishery</u>
Waits River	approximately 0.5 miles from the confluence.

The extent of the fishery is from the Pike Hill Brook/Waits River confluence to samples 03-SD-06/03-SW-06.

Note: Pike Hill Brook is not
a documented fishery.

4.1.3.3.1 Food Chain Individual

Waits River is subject to actual contamination based on an observed release to the fishery [1, p. 51620; 78, p. 11; 79, p. 5]. Sediment and surface water sample analytical results document the presence of hazardous substances (copper and zinc) with a Bioaccumulation Potential Factor Value of 500 or greater in observed release samples [2, pp. B-6, B-20; 78, p. 11; 79, p. 5]. The fishery within the area of actual contamination has been scored as Level II concentrations because the actual contamination is based on sediment and surface water samples. Therefore, a Food Chain Individual Factor Value of 45 is assigned [1, p. 51620].

Sample IDs: MALF14 (03-SW-05); D00395 (03-SD-05); D00394 (03-SD-06).

Hazardous Substance: Copper, Zinc

Bioaccumulation Potential: 50,000 (Copper)

<u>Identity of Fishery</u>	<u>Type of Surface Water Body</u>	<u>Reference</u>	<u>Dilution Weight</u>
Waits River	Moderate to Large Stream	[1, p. 51613, Tab. 4-13; 42; 65; 74]	0.01

=====

Food Chain Individual Factor Value: 45

4.1.3.3.2 Population4.1.3.3.2.1 Level I Concentrations

No fisheries subject to actual contamination within the target distance limit have been identified for Level I concentrations because no tissue samples have been collected from aquatic human food chain organisms. Therefore, Waits River was scored for Level II concentrations based on surface water and sediment samples.

<u>Identity of</u> <u>Fishery</u>	<u>Annual Production</u> <u>(pounds)</u>	<u>Reference</u>	<u>Human Food Chain</u> <u>Population Value</u>
--------------------------------------	---	------------------	--

Sum of Human Food Chain Population Values:0

=====

Level I Concentrations Factor Value:0

4.1.3.3.2.2 Level II Concentrations

Waits River supports fish and is used for fishing [37]. The Waits River was stocked with approximately 1,272 pounds of trout (brook trout, round trout, and rainbow trout) [42]. Based on surface water and sediment sample analytical data, the area from the PPE to the most downstream sample collection point at 03-SD-06 is subject to Level II concentrations [78, p. 11].

<u>Identity of Fishery</u>	<u>Approximate Annual Production (pounds)</u>	<u>Reference</u>	<u>Human Food Chain Population Value</u>
Waits River	>0	[1, p. 51621, Tab. 4B18; 42]	0.03

=====

Level II Concentrations Factor Value: 0.03

4.1.3.3.2.3 Potential Human Food Chain Contamination

According to the HRS Guidance Draft (Interim Final) Manual, A Human food chain production can be estimated based on production data or stocking rate data@ [1; 3, p. 305]. The Waits River is stocked annually with approximately 1,272 pounds of trout (brook trout, round trout, and rainbow trout) [42]. However, information pertaining to stock or production data are not available for the Connecticut River. Therefore, a minimum of 0 to 100 pounds of fish are presumed removed from the Connecticut River annually [1, p. 51621, Tab. 4-18].

Identity of Fishery	Annual Production (pounds)	Type of Surface Water Body+	Average Annual Flow	Ref.	Population Value (P_i)#	Dilution Weight (D_i)	$P_i \times D_i$
Waits River**	>0	MLS	>100 to 1,000 cfs	[42; 65;74]	0.03	0.01	0.0003
CT. River	>0	LSR	4,196.3* cfs	[64;66-] 71	0.03	0.001	0.00003

Notes:

+ = [1, p. 51613, Tab. 4-13]

= [1, p. 51621, Tab. 4-18]

CT = Connecticut River

cfs = cubic feet per second

> = greater than

Ref. = Reference

* = the flow rate for the Connecticut River at the Waits River confluence.

** = Represents the portion of Waits River from the most documented downstream observed release sample 03-SD-06 to the rivers confluence with the Connecticut River.

MLS = Moderate to large stream

LSR = Large stream to river

Sum of $P_i \times D_i$:0.00033
(Sum of $P_i \times D_i$)/10:0.000033

=====

Potential Human Food Chain Contamination Factor Value:0.000033

SWOF/Environment-Toxicity/Persistence/Bioaccumulation

4.1.4.2 WASTE CHARACTERISTICS

4.1.4.2.1 Ecosystem Toxicity/Persistence/Bioaccumulation

Hazardous Substance	Source No.	Ecosystem Toxicity Factor Value	Persistence Factor Value	Ecosystem toxicity/Persistence factor Value (Table 4-20)#	Ref.
Aluminum	1	100	1	100	[2, p. BI-1]
Antimony	1	100	1	100	[2, p. BI-1]
Arsenic	1	10	1	10	[2, p. BI-1]
Barium	1	1	1	1	[2, p. BI-1]
Beryllium	1	NL	1	<>	[2, p. BI-2]
Cadmium	1	10,000	1	10,000	[2, p. BI-2]
Chromium	1	10,000	1	10,000	[2, p. BI-3]
Cobalt	1	NL	1	<>	[2, p. BI-3]
Copper	1	1,000	1	1,000	[2, p. BI-3]
Cyanide	1	1,000	1	1,000	[2, p. BI-4]
Iron	1	10	1	10	[2, p. BI-8]
Lead	1	1,000	1	1,000	[2, p. BI-8]
Magnesium	1	NL	NL	<>	
Manganese	1	NL	1	<>	[2, p. BI-8]
Mercury	1	10,000	1	10,000	[2, p. BI-8]
Nickel	1	100	1	100	[2, p. BI-9]
Potassium	1	NL	NL	<>	
Selenium	1	1,000	1	1,000	[2, p. BI-10]
Silver	1	10,000	1	10,000	[2, p. BI-10]
Sodium	1	NL	NL	<>	
Vanadium	1	NL	1	<>	[2, p. BI-12]
Zinc	1	10	1	10	[2, p. BI-12]

= [1, p. 51622]

No. = Number

Ref = Reference

NL = Not listed in SCDM.

<> = Not calculated due to not listed in SCDM

From HRS Table 4-20, an ecosystem toxicity factor value of 10,000 and a persistence factor value of 1 are assigned an ecosystem toxicity/persistence factor value of 10,000 [1, p. 51622].

The highest ecosystem toxicity/persistence factor value is 10,000 for cadmium, chromium, silver, and mercury.

Hazardous Substance	Ecosystem Toxicity/Persistence Factor Value	Ecosystem Bio-accumulation Factor Value (Section 4.1.3.2.1.2)#	Toxicity/Persistence/Bioaccumulation Factor Value (Table 4-21)+	Ref.
Aluminum	100	5,000	5E+05	[2, p. BI-1]
Antimony	100	5	500	[2, p. BI-1]
Arsenic	10	5,000	50,000	[2, p. BI-1]
Barium	1	500	500	[2, p. BI-1]
Beryllium	<>	50	<>	[2, p. BI-2]
Cadmium	10,000	50,000	5E+08	[2, p. BI-2]
Chromium	10,000	500	5E+06	[2, p. BI-3]
Cobalt	<>	5,000	<>	[2, p. BI-3]
Copper	1,000	5,000	5E+06	[2, p. BI-3]
Cyanide	1,000	0.5	500	[2, p. BI-4]
Iron	10	5,000	50,000	[2, p. BI-8]

Hazardous Substance	Ecosystem Toxicity/ Persistence Factor Value	Bio- accumulation Factor Value (Section 4.1.3.2.1.2)#	Ecosystem Toxicity/ Persistence/ Bioaccumula- Factor Value (Table 4-21)+	Ref.
Lead	1,000	50,000	5E+07	[2, p. BI-8]
Magnesium	<>	NL	<>	
Manganese	<>	50,000	<>	[2, p. BI-8]
Mercury	10,000	50,000	5E+08	[2, p. BI-8]
Nickel	100	500	50,000	[2, p. BI-9]
Potassium	<>	NL	<>	
Selenium	1,000	500	5E+05	[2, p. BI-10]
Silver	10,000	50	5E+05	[2, p. BI-10]
Sodium	<>	NL	<>	
Vanadium	<>	500	<>	[2, p. BI-12]
Zinc	10	50,000	5E+05	[2, p. BI-12]

= [1, p. 51622]

+ = [1, p. 51623]

<> = Not calculated due to not listed in SCDM

From HRS Table 4-21, an ecosystem toxicity/persistence factor value of 10,000 and a bioaccumulation factor value of 50,000 are assigned an ecosystem toxicity/persistence/bioaccumulation factor value of 5E+08 [1, p.51623].

The highest ecosystem toxicity/persistence/bioaccumulation assigned factor value is 5E+08 for cadmium and mercury.

=====

Ecosystem Toxicity/Persistence/Bioaccumulation Factor Value:5E+08

4.1.4.2.2. Hazardous Waste Quantity

Source Number	Source Hazardous Waste Quantity Value (Section 2.4.2.1.5.)	Is source hazardous constituent quantity data complete? (yes/no)
1	16,120.2	No

Sum of values:16,120.2

A Surface Water Pathway Hazardous Waste Quantity Value greater than 10,000, but less than or equal to 1,000,000, is assigned a Hazardous Waste Quantity Factor Value of 10,000 [1, p. 51591, Tab. 2-6].

4.1.4.2.3. Waste Characteristics Factor Category Value

An ecosystem toxicity/persistence factor value of 4,000 is multiplied by the hazardous waste quantity factor value for the watershed (10,000) , subject to a maximum value of 1E+08 [1, pp. 51592, Tab. 2-7]

$$10,000 \times 10,000 = 1E+08$$

Ecosystem toxicity/persistence factor value
X hazardous waste quantity factor value:1E+08

The product of the ecosystem toxicity/persistence factor value and hazardous waste quantity factor value for the watershed (1E+08) is multiplied by the bioaccumulation potential factor value (50,000) in order to determine the waste characteristics factor category value, subject to a maximum of 1E+12 [1, p. 51620].

$$1E+08 \times 50,000 = 5E+12 \text{ (exceeds maximum value; therefore, assign maximum value of } 1E+12)$$

(Ecosystem toxicity/persistence X hazardous waste quantity)
X bioaccumulation potential factor value:1E+12

From HRS Table 2-7, a toxicity/persistence H hazardous waste quantity H bioaccumulation potential factor value of 1E+12 is assigned an environmental threat - waste characteristics factor category value of 1,000 [1, pp. 51620, 51592, Tab. 2-7].

=====

Hazardous Waste Quantity Factor Value: 10,000
Waste Characteristics Factor Category Value: 1,000

4.1.4.3 ENVIRONMENTAL THREAT - TARGETS

Overland flow from the northern mine discharges into Pike Hill Brook. The PPE is located at Tailings Pile No. 2 in Pike Hill Brook [59; 60]. Pike Hill Brook flows approximately 4.5 miles east and discharges into Waits River (Figure 2) [4-9; 26, pp. 7-8].

Pike Hill Brook, Waits River, and Connecticut River are "State-designated areas for the protection and maintenance of aquatic life", designated under section 305(a) of the Clean Water Act, as amended [1, p. 51624, Tab. 4-23; 56]. Additionally, there are 2.5 miles of wetland frontage along Pike Hill Brook and 1.3 miles of wetland frontage along Waits River within the target distance limit [30-35; 51; 70; 80].

The Eastern Small-footed bat (*Myotis leibii*), a state threatened species, is located within a 0.25 mile radius of the site [19]. The bat's habitat has been documented to be within the surface water pathway and is, therefore, subject to Level II concentrations [1, p. 51624;10]. No other Federal or State-threatened or endangered species are known to exist along the 15-mile surface water pathway [19; 21].

In November 1999, an EPA contractor collected surface water and sediment samples in Cookville Brook, Pike Hill Brook, and Waits River. These samples were collected in successive order from downstream to upstream locations during the sampling event, and are considered similar to samples from background locations (Figure 2) [26, pp.31-44].

Observed release criteria for surface water samples have been established via chemical analysis [78, p. 11; 79, p. 5].

Level I Concentrations

Not scored.

Most Distant Level II Sample

Sample ID: Location D00394 (03-SD-06)

Distance from the probable point of entry: approximately 4.5 miles (Figure 2)

Reference: [26, pp. 32-33; 78, p. 11]

4.1.4.3.1 Sensitive Environments4.1.4.3.1.1. Level I ConcentrationsSensitive Environments

Not scored.

	Distance from Probable Point of Entry to Nearest Point of Sensitive Environment	Reference	Sensitive Environment Value(s)
<u>Sensitive Environment</u>	<u>Environment</u>		

Sum of Sensitive Environments Value:0

Wetlands

<u>Wetland</u>	<u>Wetland Frontage</u>	<u>Reference</u>
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Total Wetland Frontage:

Wetland Value:0

Sum of Sensitive Environments Value + Wetland Value:0

=====

Level I Concentrations Factor Value:0

4.1.4.3.1.2. Level II Concentrations

Observed release criteria for surface water and sediment samples have been established via chemical analysis [78, p. 11; 79, p. 5]. Surface water and sediment sample locations in Pike Hill Brook and Waits River are subject to actual contamination under Level II concentrations (Figure 2) [78, p. 11; 79, p. 5]. The Level II area in Pike Hill Brook and Waits River extends from the PPE to sample location D00394 (03-SD-06) (Figure 2) [26, pp. 32-35; 78, p. 11]. Wetlands documented in the Waits River are located downstream from the Level II sample (03-SD-06), therefore, these wetlands are scored as subject to potential contamination [30]. Listed below are sensitive environments considered subject to Level II concentrations [1, p. 51625].

Sensitive Environments

Type of Surface Water Body	Sensitive Environment	Reference(s)	Sensitive Environment Value(s) (Tbl.4-23)
MS (Pike Hill Brook)	Habitat known to be used by a State threatened species (Eastern Small-footed bat <i>Myotis leibii</i>)	[4; 10; 19; 21]	50
	Distance from Probable Point of Entry to Nearest Point of Sensitive Environment		Sensitive Environment Value(s)
<u>Sensitive Environment</u>	<u>Environment</u>	<u>Reference</u>	<u>Value(s)</u>
State-designated area for the protection and maintenance of aquatic life under Section 305(a) of the Clean Water Act	0 feet from PPE (Pike Hill Brook)	*	5
	4.5 miles from PPE (Waits River)	*	5

* = [1, p. 51624, Tab. 4-23; 56, pp. 7,23,40]
PPE = probable point of entry

Sum of Sensitive Environments Value: 60

Wetlands

Wetland	Wetland Frontage	Reference
MS Pike Hill Brook 26, pp. 40-41; 80]	2.5 miles	[1, p. 51625, Tab. 4-24;
		Total Wetland Frontage:2.5 miles Wetland Value: 75

Sum of Sensitive Environments Value + Wetland Value:135

Note:
MS = minimal stream

=====
Level II Concentrations Factor Value: 135

4.1.4.3.1.3 Potential ContaminationSensitive EnvironmentsWetlands

Wetlands as defined in 40 CFR Section 230.3 were documented along Waits River between the most distant downstream sample documenting Level II contamination and the 15-mile downstream mile target distance limit (Figure 3) [30-35].

Type of Surface Water Body	Wetlands Frontage (Table 4-13)	Reference(s)	Wetlands Value for Type of Surface Water Body (Table 4-24)
MLS (Waits River)	1.3 miles	[30;34; 51]	50

Note:

MLS = moderate to large stream

Type of Surface Water Body	Sum of Sensitive Environment Values (S_j)	Wetland Frontage Value (W_j)	Dilution Weight (D_j)	$D_j(W_j + S_j)$
MLS (Waits River)	0	50	0.01	0.5

$$\text{Sum of } D_j(W_j + S_j) : 0.5$$

$$(\text{Sum of } D_j(W_j + S_j)) / 10 : 0.05$$

=====

Potential Contamination Factor Value: 0.05

4.2 GROUND WATER TO SURFACE WATER MIGRATION COMPONENT

**4.2.1.1 DEFINITION OF HAZARDOUS SUBSTANCE MIGRATION PATH FOR GROUND WATER
TO SURFACE WATER COMPONENT**

Not scored.

A copy of *Appendix A* is available at the EPA Headquarters Superfund Docket:

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